DOCUMENT RESUME

ED 024 574 24 SE 004 974

By- Smith, Herbert A.

An Analysis of a Typical Instructional Unit in Junior High School Science to Determine the Explicit and Implicit Concept Loading Involved. Final Report.

Colorado State Univ., Ft. Collins.
Spons Agency- Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No- BR-7-8176
Pub Date Jun 68
Contract- OEC-1-7-078176-4201
Note- 17p.
EDRS Price MF-$0.25 HC-$0.95
Descriptors- Concept Formation, Course Content, *Curriculum Evaluation, *Earth Science, *Learning, Science Courses, *Scientific Concepts, *Secondary School Science
Identifiers- Earth Science Curriculum Project, Investigating the Earth, U S Department of Health Education and Welfare

This study involved examining an instructional unit with regard to its concept content and appropriateness for its target audience. The study attempted to determine (1) what concepts are treated explicitly or implicitly, (2) whether there is a hierarchical conceptual structure within the unit, (3) what level of sophistication is required to understand the materials presented, and (4) what professional judgments can be rendered relative to the suitability and quality of the materials. Among the conclusions are the following. A large number of concepts are implicitly involved in addition to those explicitly considered. Although the explicit concept load is heavy, the implicit concept load is much greater and is almost certainly ascribing to junior high school students a level of sophistication which extremely few of them possess. There is little evidence that the authors conceived it to be their function to build a more functional, systematic sophisticated conceptual hierarchy. Concepts of physics, mathematics, and astronomy are assumed. In summary, the material i s not particularly well organized, it lacks conceptual continuity, it assumes unrealistic student backgrounds, and it has surprising omissions. (BC)

Final Report
Project No. 7-8176
Grant No. OEC-1-7-078176-4201

PA-24

AN ANALYSIS OF A TYPICAL INSTRUCTIONAL UNIT IN JUNIOR HIGH SCHOOL SCIENCE TO DETERMINE THE EXPLICIT AND IMPLICIT CONCEPT LOADING INVOLVED

June, 1968

U.S. Department of
Health, Education, and Welfare

Office of Education
Bureau of Research

Final Report
Project No. 7-8176
Grant No. OEC-1-7-078176-4201

AN ANALYSIS OF A TYPICAL INSTRUCTIONAL UNIT IN JUNIOR HIGH SCHOOL SCIENCE TO DETERMINE THE EXPLICIT AND IMPLICIT CONCEPT LOADING INVOLVED

June, 1968

U.S. Department of
Health, Education, and Welfare

Office of Education
Bureau of Research

Final Report
Project No. 7-8176
Grant No. OEC-1-7-078176-4201

AN ANALYSIS OF A TYPICAL INSTRUCTIONAL UNIT IN JUNIOR HIGH SCHOOL SCIENCE TO DETERMINE THE EXPLICIT AND IMPLICIT CONCEPT LOADING INVOLVED

Herbert A. Smith
Colorado State University
Fort Collins, Colorado

June, 1968

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. Department of
Health, Education, and Welfare

Office of Education
Bureau of Research

INTRODUCTION

It was the intent of this research to make a critical examination of an instructional unit prepared for use in a junior high school setting. The unit was to be analyzed specifically with attention to concept loadings, both implicit and explicit, and to note the presence or lack of ordering or hierarchical arrangement of concepts included.

In order to carry out the research, considerable attention was devoted to the nature of concepts. In the context of this report "concept" is considered as a term referring to the process of abstracting a meaningful and insightful understanding from the common elements present in a series of related or associated circumstances and for which a label or language symbol commonly exists. It is obvious that a perceptual base must exist for concept formation.

It is further necessary to recognize that there are inherent differences among the kinds of concepts which may be held. Some of them are concerned with categories, class, or structure which is perhaps the lowest level of abstraction. Thus, through the synthesis of perceptual experiences, the abstraction of "chair" is acquired and is a language symbol used to identify those objects which possess four legs, a seat and a back support and which are used to sit upon. Another type of concept relates to processes or phenomena in which a time-continuum is ordinarily involved and includes such processes as "erosion," "germination," "melting," and "fermentation." Obviously, such terms embrace a host of lesser concepts and are normally more difficult to acquire than "class or category" concepts. Still a third class of concepts relates to ideas for which there can be no direct physical referent and which must be abstracted from a multiplicity of perceptions. Their nature is inferred rather than observed. Included in such a list would be such terms as "motion," "time," and "space."

It is obvious that the more remote a particular concept may be from its perceptual bases, the greater the opportunity for confusion and the real possibility that individuals using the same "label" are not really talking about the same thing. The possibility, also, of vastly different levels in the sophistication of the understanding which the "label" implies also exists among students. Closely related and particularly pertinent in the educational process is the fact that a well known "label" may be applied with new meanings, particularly in science. Examples would include "work," "face," "force," and many other terms. Students are also expected to learn to make determinations of meaning within what might be described as

the sphere of "contextual relativity." Such interpretations must be made in such instances as when allusions are made to "small," or "cool" stars. In effect, the process of education is inherently the process of developing new, and perhaps more importantly, enlarging, refining and extending the conceptual constructs held. These conceptual constructs are the individual's intellectual working capital.

All concepts must have a perceptual base regardless of how remote or inadequate such a base may be. In any teaching situation, certain assumptions are made relative to the concepts held by those being instructed. Even more fundamentally, there is an assumption that the perceptual base necessary to the formation of such concepts is held in common by all members of the group. More specifically, such a perceptual base must be expected to have been developed through the widely differing experiences of students with diverse backgrounds. Since an instructional unit is expected to go further in introducing new and providing for the expansion of old concepts, it is expected that some new perceptual bases will be provided by textual materials, but the assumption of certain already existing conceptual constructs in the minds of students is always (and necessarily) made.

Unfortunately, one of the historical limitations of the textbook has been its reliance on symbolic representation through words, diagrams and illustrations. For students who are suffering perceptual and/or conceptual deficiencies or for whom the existence of the assumed base for the conceptualization of new materials is unwarranted, the further extensior into symbolic representation may be disastrous.

THE RESEARCH PROBLEM

The problem of this study had its origin in the fact that educational literature is replete with references to concept development. However, few analyses relating to concept load or concept hierarchies which are implicit in instructional materials have been made. Most research has concerned itself with extremely narrow aspects of concept formation and has been more common in psychological than in instructional or curricular research.

In recent years, many new curriculum projects have been funded and considerable instructional material has been developed, much of it by academicians who were essentially unfamiliar with either instruction at the elementary and secondary school level or with

psychological and educational theory. Since large teams of experts were often involved in the large scale curriculum projects, substantial problems in providing for continuity, a consistent writing style, and maintenance of reasonable variations in difficulty were common.

For these reasons it was decided to critically examine one of the units in one of the new science curricula, Unit IV, "Earth and the Universe" in Investigating the Earth produced by the Earth Science Curriculum Project in 1964. Chapter 26 was selected for a particularly detailed analysis because it seemed from a cursory examination to involve a great many concepts. It should be emphasized that the version of the textbook used in the present analysis was experimental and that its creators were well aware that further improvements and refinement of the materials were needed.

More specifically, answers to the following questions were sought:

1. What concepts are treated explicitly or implicitly?

2. Is there a hierarchical conceptual structure within the unit?

3. What is the level of sophistication required to understand the materials presented?

4. What professional judgments can be rendered relative to the suitability and quality of the materials produced for the target audience?

PROCEDURES

Both the verbal and graphic presentations of Unit IV were studied carefully and detailed notes and comments were made. A list of words with high concept loadings included in the Unit was made and is included as Appendix A. Concept charts were developed for the individual chapters which show the major concepts involved. The charts are included as Appendix B. As the discussion below will indicate, it was not feasible to trace out every conceivable concept involved in the charts and the charts show only major features. A detailed analysis was then made on Chapter 26 to determine the precise character of the conceptual load of the material.

ANALYSIS

A casual examination of Chapter 26 and the concept analysis charts reveals that the content is extraordinarily rich in concepts. It also makes substantial assumptions about the perceptual background and experience and about the conceptual maturity and sophistication of junior high school students. Essential to a real understanding of the entire chapter are the concepts of gravitation and motion. Although gravitation is introduced earlier in the book, no review or transition to Chapter 26 is provided. Similarly, the several motions and apparent motions of the moon are inadequately treated. In general, it can be stated that the chapter appears to make assumptions about the backgrounds of junior high school students which are unwarranted.

A detailed section by section analysis indicates some of the apparent difficulties in this chapter. In addition to the difficulties of the vocabulary itself, there are unusual and sometimes questionable uses or constructions involving common words. The following examples are illustrative.

(a) Page 26-1. "Face" in this context means surface. It is also likely to carry an anthropomorphic connotation, especially in view of the common folklore associated with the moon.

(b) Page 26-1. "No weather; there can be no such change." One force is obviously overlooked. Considering the large temperature changes on the moon's surface, large tensions through contraction and expansion must be produced. Over time, such forces should produce some changes.

(c) Page 26-1. "dead, timeless companion" (In reference to the moon). What does saying the moon is "dead" mean? The intent is only that the moon will not sustain life. However, how can a thing which has never been alive be dead? There is a real possibility that students would interpret this statement as indicating the moon had at one time supported life. "Timeless" has a poetic ring but its meaning in this context is obscure.

(d) Page 26-1. "Cosmic radiation." Just what meaning such a phrase might convey to junior high school students when unelaborated is speculative. It seems likely to carry little meaning.

(e) Page 26-1. "Probe" in the sense the word is employed means a highly sophisticated sensing and transmitting device. No explanation of the meaning is provided.

(f) Page 26-2. "Radar pulse" and "radio pulse" are used synonomously. It is unnecessarily complicating.

(g) Figure 26-2. This figure would appear to offer formidable difficulties to students who have not had geometry. The term "zenith" is used but not explained. In addition, the construction is in error. Obviously, only the surface of the moon can be observed. Yet the construction would make it appear that observations are made to the center of the moon.

(i) Page 26-3. "Focus." Reference is made to the fact that the earth is located at one focus of the elliptical orbit of the moon. Ellipse, orbit and focus are all inadequately defined.

(j) Page 26-4. "It subtends (covers) the same angle (about ½ degree) in the sky as the moon." This refers to the angle subtended by an aspirin tablet. Although the context is suggestive, it does not make clearly evident the fact that a subtended angle for any object is a function of distance and is not intrinsic to any object, such as the aspirin tablet.

(k) Table 26-1, page 26-5. This table as well as the text assumes that students understand such terms as mass, mean, density, rotation, revolution, and period. The term 'visual magnitude' is used without explanation although the meaning is provided in a subsequent chapter (pp. 28-4 and 28-5).

(l) Page 26-6. The term "barycenter" is introduced in this section. The concept of point-mass is likely to be difficult. In addition, the concept of "moments" is implicitly involved. The barycenter is described as being the point which is in elliptical orbit. The graphic representation (Figure 26-6) is defective since it shows the barycenter outside the earth and the "fulcrum" is not on the line indicating the earth-moon system orbit.

(m) Page 26-13. The fact that the same surface of the moon is constantly turned toward the earth is made. The statement that "It arises from the powerful tidal pull on the moon caused by the gravitational attraction of the earth" is made. This hardly explains the phenomenon.

(n) Page 26-15. In Figure 26-14 the terms sidereal and synodic months are introduced. These are involved concepts and are not treated in the textual materials. The figures themselves are inadequate and confusing and, in part, in error. The scale (sun, earth and moon) is poorly chosen. It seems doubtful that anyone not knowing in advance what sidereal and synodic meant could make any reasonable interpretation from the Figure.

CONCLUSIONS

1. Major concepts treated in Unit IV of Investigating the Earth are revealed, in part, in the chapter analysis charts (Appendix B). A large number of concepts are obviously implicitly involved in addition to those explicitly considered. One example would include the "atomic clock." Although the reference to the clock is fleeting, it requires a substantial understanding of such concepts as "half-life," "randomness," "radioactivity" and "uniform rate of decay" to understand what an "atomic clock" really is. The student must further understand that atomic disintegration (another "concept" label) is unaffected by normal environmental conditions. Other terms requiring similar congeries of concepts to make them meaningful include "zenith," "sidereal" and "synodic." These, too, are used with the tacit assumption that the necessary perceptual base for their understanding exists. In summary, the explicit concept load is heavy, but the implicit concept load is much greater and is almost certainly projecting a level of sophistication to junior high school students which extremely few of them would possess.

2. Although the concept charts in Appendix B were abstracted from the chapters, the material is not, in general, "concept" oriented. Much of it is descriptive and narrative in style at a rather sophisticated level. The material is topically arranged and there is not consistently a large carry-over from section to section. There is little evidence that conceptual continuity is consciously attempted or that the authors conceived it to be their function to build a more functional, systematic and sophisticated conceptual hierarchy.

3. Although objective data are unavailable and their collection was beyond the scope of this study, the analysis of the unit indicates that the content is difficult and sophisticated material. Concepts of physics, mathematics, and astronomy are assumed which the majority of junior high students will not possess, at least in the sophisticated degree implicitly involved in this unit.

4. Based on teaching at the junior high school level, years of involvement with curriculum materials and with science education, the material appears to be too difficult and too advanced for typical junior high school students. The material is not particularly well organized, it lacks conceptual continuity, it assumes unrealistic student backgrounds, and it has surprising omissions. No reference is made, for example, to seasons, the earth's own orbit (except incidentally in connection with the earth-moon system) and time reckoning, although it is obviously assumed that students understand that the bases for measures of time are the earth's rotation on its axis and on its revolution around the sun.

COMMENT

The study suggests that far greater attention is needed in developing instructional materials to the inherent concept loads involved. It seems reasonable, too, that a preliminary step in preparing materials might consist of identifying concepts to be taught, the concepts to be assumed and the level of conceptual sophistication expected to be attained. Such an analysis as a preliminary to formal preparation of materials might be expected to result in materials which are more consistently organized and more appropriate to the intended target audience.

SELECTED BIBLIOGRAPHY

1. Gagné, Robert M. The Conditions of Learning. Holt, Rinehart and Winston, Inc., New York, 1965.

2. Henderson, Kenneth B. "A Logical Model for Conceptualizing and Other Related Activities." Educational Theory, 13(October, 1963) 277-284.

3. Novak, Joseph D. "A Model for the Interpretation and Analysis of Concept Formation." Journal for Research in Science Teaching, 3(Issue 1, 1965) 72-83.

4. Novak, Joseph D. "The Role of Concepts in Science Teaching." Analysis of Concept Learning. Academic Press Inc., New York, 1966, pp. 239-254.

5. Smith, Herbert A. "The Teaching of a Concept: An Illusive Objective." The Science Teacher, 33(March, 1966) 103-112.

6. Fagatz, Jeanette and Fagatz, Glenn E. "The Effects of Exemplar or Nonexemplar Instances of Form, Color, and Number Dimensions on Concept Attainment of Second Grade Pupils." The Teachers College Journal, 3(December, 1967) 96-99.

7. Walker, William L. "The Attainment of Science Concepts by Elementary School Children." The Teachers College Journal, 3(December, 1967) 92-96.

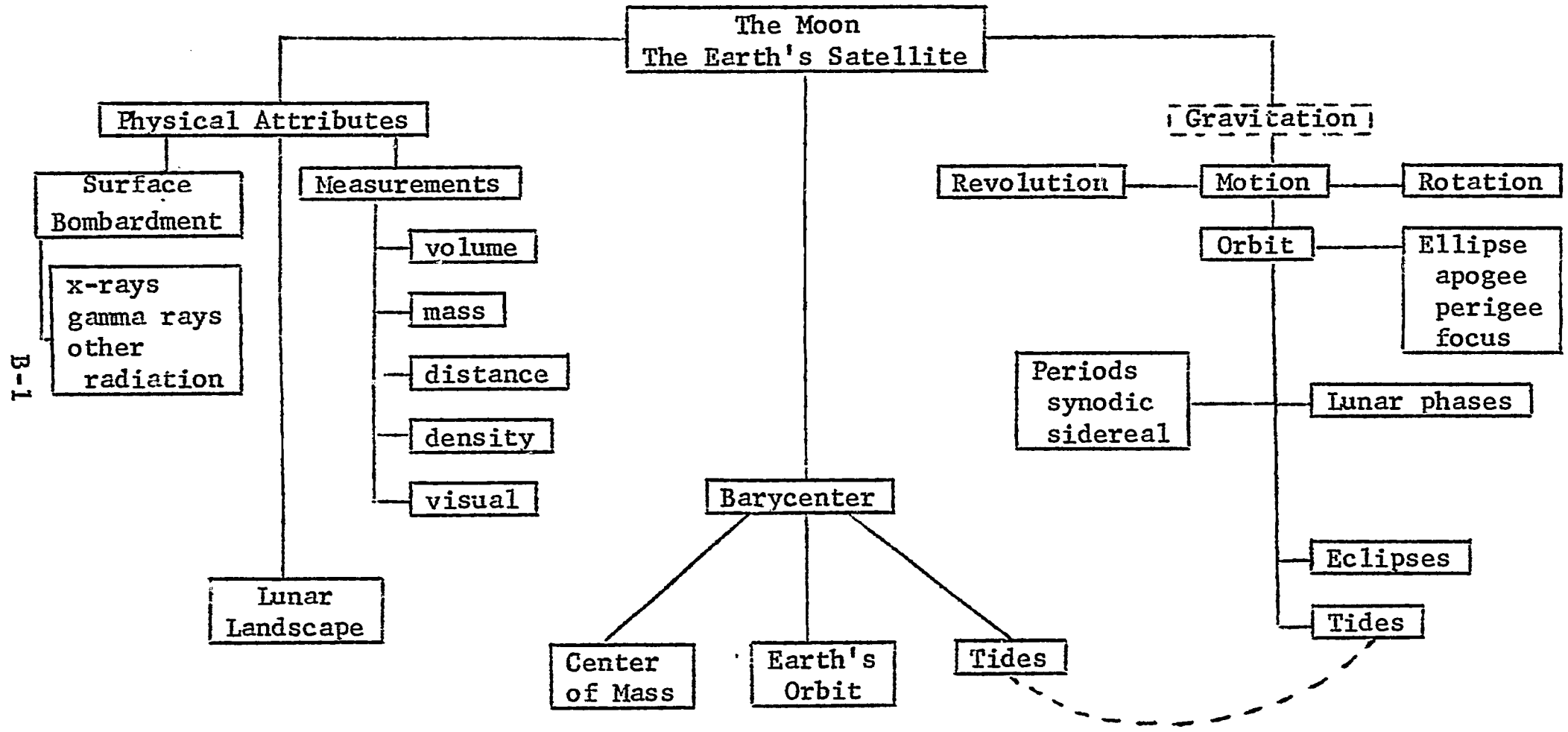
APPENDIX A

SOME WORDS WITH HIGH CONCEPT LOADINGS IN UNIT IV

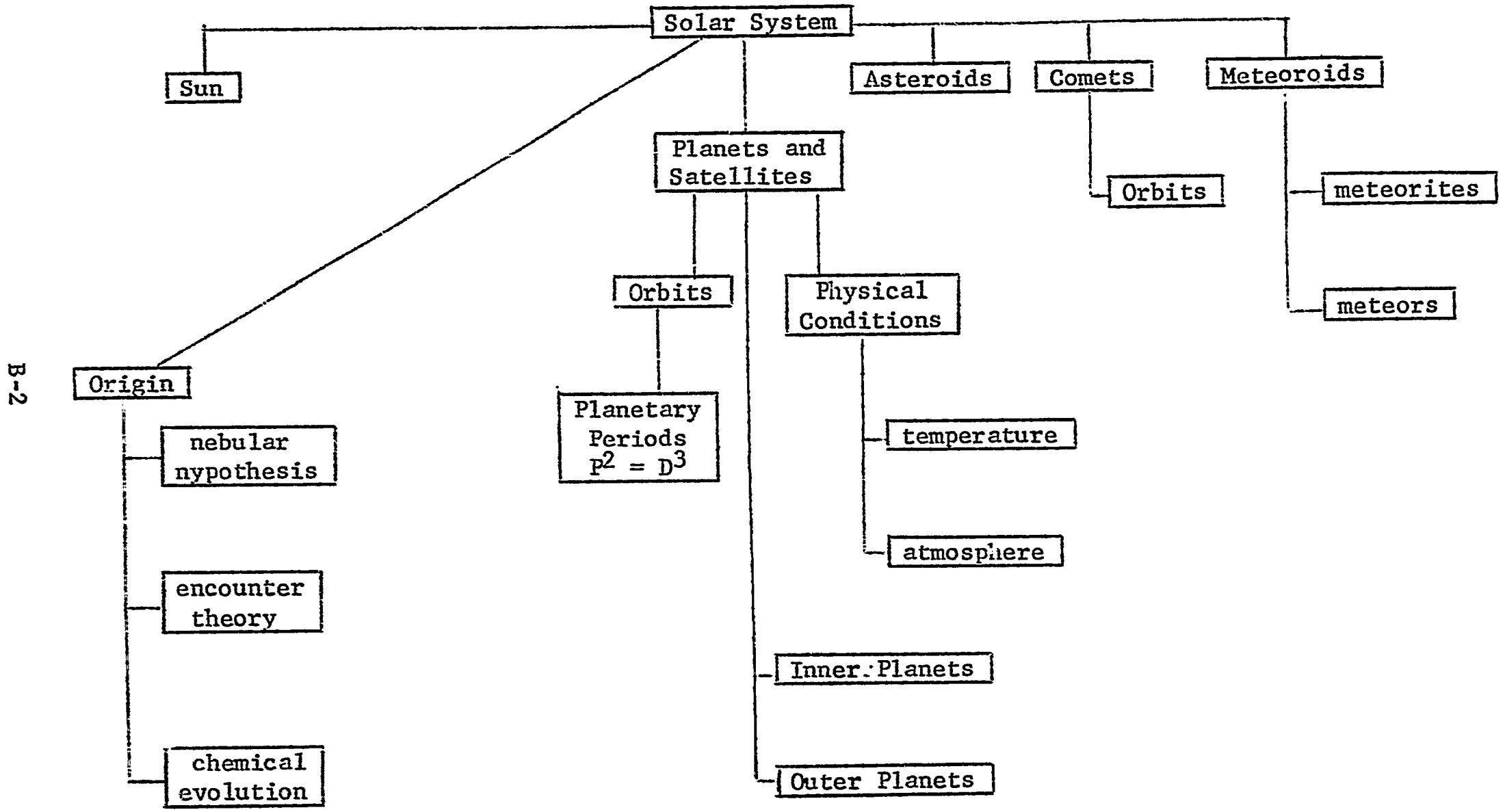
acceleration
angle
apex
apogee
astronaut
atmosphere
atomic
atomic clock
atoms
axis
balance
balance point
barycenter
boiling point
bombardment
celestial body
center of mass
circumference
collision
corona
cosmic
crater
crescent
curvature
diameter
earth clock
earthshine
eclipse
electromagnetic
elliptical
energy
environment
equation
equivalent
erosion
extracted
focus (of ellipse)
force
friction
Gamma ray
gravitation
gravity
horizon
illusion
impact
inclined
inquiry
insulated
ions
Jupiter
lava
lunar
mass
Mercury
meteor
meteoroids
meteorites
micrometeorites
molecules

month
moon
motion
nitrogen
optical systems
orbit
origin
outer space
oxygen
parent planet
perigee
phases of moon
pivot
pivot point
plot
radar echoes
radar pulse
radiations
radio pulse
radio wave
radius
reflected
revolve
revolution
rotate
sattelite
sidereal
solar system
solar
space age
space probe
space station
speed of light
subtends
sun
surveyors
symbol
synodic
target
technology
telescope
temperature
texture
tide
tilt
time
transmitted
triangle
uniform path
vacuum
variable motion
Venus
volcanic
volume
weather
weathering
weigh
weight
x-ray
zenith

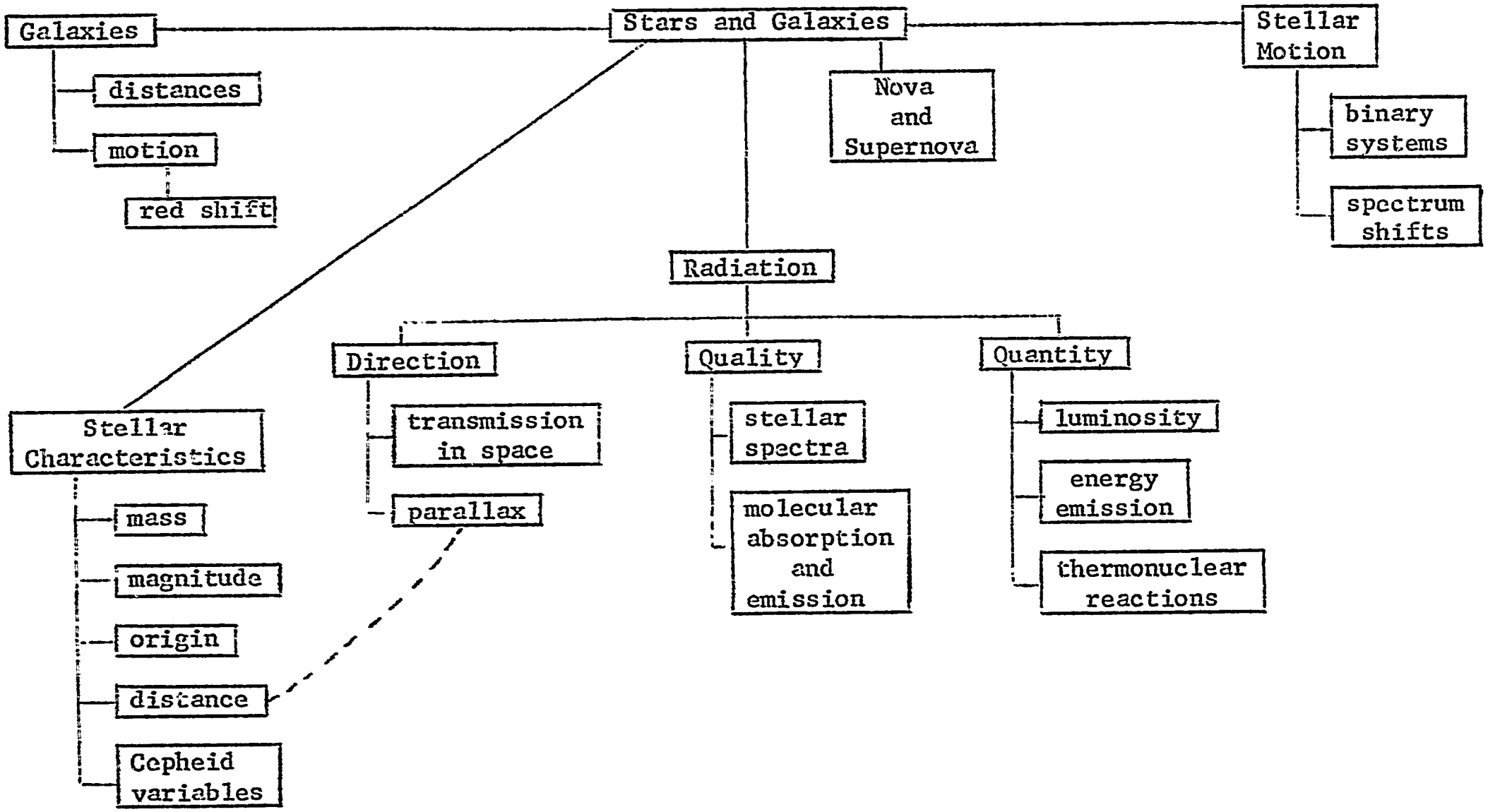
APPENDIX B
CONCEPT CHART - CHAPTER 26



CONCEPT CHART - CHAPTERS 27 AND 29



CONCEPT CHART - CHAPTER 28



CONCEPT CHART - CHAPTER 30